7 June 2023

Spencer Shute
Environment and Approvals Manager
Atlas Iron Pty Ltd
Level 17
300 Murray Street
Perth WA 6000
via email

Dear Spencer,

McPhee Creek Groundwater Dependent Vegetation Review

Biota Environmental Sciences (Biota) was commissioned to conduct a brief review of survey, vegetation mapping and impact assessment reporting completed for the McPhee Creek survey area, and provide advice and recommendations in response to comments received from the State Environmental Protection Authority (EPA) and the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW).

1.0 Introduction

The McPhee Creek survey area is located approximately 30 km north of Nullagine in the Pilbara region of Western Australia. To support the environmental impact assessment of the proposed McPhee Creek mine project, the flora and vegetation of the area has been surveyed by Ecoscape (2022) and Woodman (2014a, 2014b). The most recent survey was undertaken by Ecoscape in 2020 (Ecoscape 2022) during which they surveyed the area which is intended to encompass the mine pits and associated infrastructure (herein referred to as the "main development envelope") but did not resurvey the three creeks extending from the main development envelope towards Nullagine River, which would receive proposed mine dewatering discharge (herein referred to as the "creeks survey area"). Ecoscape did, however, review and amend vegetation mapping completed by Woodman (2014a, 2014b), particularly reclassification of some areas of groundwater dependent vegetation (GDV) based on Woodman's quadrat data.

Atlas Iron Limited (Atlas) is in the process of applying for State and Commonwealth environmental approval for the project and incorporated the results of the vegetation and flora surveys in preparing the Environmental Review Document (ERD) for the project. Atlas has since received comments from the EPA and DCCEEW in relation to impacts to GDV from the proposed project.

2.0 Appreciation of the Scope

The objectives of this exercise were to:

- review vegetation mapping, data and reporting for the McPhee Creek project conducted by Ecoscape (2022) and Woodman (2014a, 2014b);
- comment on flora species diversity and richness in the McPhee Creek survey area compared to other areas of GDV in the Pilbara;
- make a brief assessment of the likely reliance of the GDV communities within the project area on shallow groundwater, and likely sensitivity to both groundwater drawdown and increased soil moisture and/or shallower water table as a result of the proposed project's dewatering discharge; and
- make recommendations for the requirement for further survey.

3.0 Outcome of the Review

The following reports, including data and vegetation mapping, were reviewed:

- McPhee Creek Flora and Vegetation Survey (Ecoscape 2022);
- McPhee Creek Project Flora and Vegetation Assessment (Woodman 2014b);
- McPhee Creek Iron Ore Project Riparian Vegetation Mapping (Discharge Options 1, 2 and 3) (Woodman 2014a); and
- McPhee Creek Iron Ore Project Flora and Vegetation Impact Assessment (Woodman 2014c).

We found the methodology of all the surveys documented in the above reports to be comprehensive and in line with relevant EPA guidance for vegetation and flora surveys for environmental impact assessment (EPA 2016). Flora species assemblage and diversity at riparian vegetation[1] sites that were sampled for the project, were comparable to sites in similar riparian habitats in the inland Pilbara. Ecoscape (2022) reported averages of between 38 and 52 species at individual riparian vegetation sites; within the expected range. Additionally, total flora species richness recorded by Woodman (2014a) in the creeks survey area (n=165) was comparable with inland Pilbara riparian vegetation study areas Biota has surveyed previously at an average of 171 species (2010, 2014, 2016).

In 2012 and 2013, Woodman (2014a, 2014b) recorded *Eragrostis crateriformis* (Priority 3) at 70 locations, totalling over 1,300 individuals. Ecoscape (2022) did not locate any *Eragrostis crateriformis* during their 2020 survey but considered this species likely to occur. Woodman also recorded *Acacia aphanoclada* (Priority 1) and *Rostellularia adscendens* var. *latifolia* (Priority 3) in the creeks survey area. Targeted searches for significant flora were considered to be adequate and impacts to the significant flora species recorded in the main development envelope and the creeks survey area have been considered (Woodman 2014c).

With the focus of this exercise being GDV[2], we reviewed the overall methodology used in defining and mapping of GDV in the creeks survey area. As there is currently no specific formal guidance provided by EPA or DCCEEW in relation to the identification of groundwater dependent ecosystems (GDEs) or GDVs in the Pilbara region of WA, specific surveys and assessments have primarily been based on landscape indicators of GDV presence. Most creeklines in the Pilbara are ephemeral, with no surface expression of groundwater for most of the year, which makes identifying GDVs a more cryptic process

[1] Defined as the terrestrial vegetation growing directly adjacent to or within ephemeral or permanent watercourses or waterholes, that comprises distinct plant assemblages present directly or indirectly due to the presence of the watercourse or waterhole.

[2] GDV is further defined as vegetation communities that have occasional, seasonal or permanent dependence on groundwater for their maintenance (Hatton and Evans 1998).

than simply identifying vegetation associated with springs and wetlands. It is commonly accepted that vegetation associated with shallow groundwater (<10 m) is likely to be GDV (Eamus et al. 2016), with the phreatophytic tree species *Melaleuca argentea, Eucalyptus camaldulensis* and *Eucalyptus victrix* within riparian areas being the main GDV indicator species in the Pilbara (Rio Tinto 2017, 2018). We found Ecoscape's understanding of GDEs and GDVs within the survey area to be sound and in line with current research and other GDV assessments in the Pilbara (Maunsell 2006, Argus et al. 2014b, Rio Tinto 2017, 2018). We believe Ecoscape's application of previous quadrat and vegetation mapping data (primarily focussing on vegetation with a dominant overstorey stratum of GDV indicator species *Eucalyptus camaldulensis* and *Eucalyptus victrix*), hydrological information (depth to groundwater) and aerial imagery inspection to identify and map GDV to be appropriate and likely to be a good representation of on-ground conditions, although ground-truthing of amended GDV boundaries would add more confidence to the accuracy of vegetation type mapping. Within the main development envelope, not all creek areas were ground-truthed by Ecoscape according to tracklogs presented on the maps. However further ground-truthing of these areas is unlikely to result in changes to the mapping and Atlas can have a high level of confidence that the areas mapped as potential GDV are appropriate.

4.0 GDV Assessment

The vegetation units identified and mapped as potential GDV by Ecoscape were dominated by either *Eucalyptus camaldulensis* (EcApyCci) or *Eucalyptus victrix* (EvApyCci). An essential next step in assessing the potential risk to the GDV is to understand how each GDV interacts with the aquifer including their ecological water requirements and thresholds and their level of groundwater dependence.

Research demonstrates that with decreased availability of groundwater, riparian vegetation is negatively impacted at the leaf, plant and population scale (Eamus et al. 2015). A decrease in species diversity, vegetation cover, and changes in species composition (e.g. shifts from forest to shrubland) has been reported in studies conducted on riparian vegetation across the world (Cooper et al. 2003, Zinko et al. 2005, Lv et al. 2012, Merritt and Bateman 2012).

While a great deal of research has been done on GDEs, including GDV, research into individual species' responses to flux in surface water and groundwater is still developing. Even with sophisticated modelling and substantial anecdotal evidence, these factors are difficult to conclude definitively due to inherent variability found in the natural environment, e.g. the maximum rooting depth of plant species, changes in water sourcing strategy at various growth stages, alluvium characteristics etc. (Eamus et al. 2015, Rio Tinto 2017, 2018, Grierson et al. 2017).

Eucalyptus camaldulensis, a tree species commonly found in riparian vegetation communities in the inland Pilbara, is widely considered to be a facultative phreatophyte (a plant that may draw on groundwater for all or part of their water needs, but can also meet their water needs from available water in the unsaturated soil profile after rainfall) (McFarlane 2015, Rio Tinto 2018, 2020). *Eucalyptus victrix,* also a common feature of riparian and floodplain vegetation in the Pilbara, is considered to a lesser extent to be a facultative phreatophyte, or a vadophyte (a species which meets all of its water needs from available soil water) (Froend 2009, McFarlane 2015, Rio Tinto 2018, 2020). These two species are dominant or co-dominant in the uppermost stratum of vegetation mapped throughout the creeks survey area (Ecoscape 2022) meaning it is beneficial to understand their likely sensitivity to fluctuations in depth to groundwater and surface water availability when considering the impacts of dewatering and dewatering discharge.

The EPA has raised concerns about the potential impact to *Eucalyptus victrix* as a result of dewatering discharge, and the potential for a transition from *E. victrix* to *E. camaldulensis* dominated vegetation in parts of the survey area. The literature regarding water use and sensitivity indicates that while *E. victrix* may display certain adaptations to several weeks of flooding, e.g. adventitious roots (roots arising from stems or leaves in response to stress), or stem hypertrophy (enlargement of the stem from swelling, not growth), the species is not tolerant of long-term flooding, such as that which may occur from consistent dewatering discharge over a period of years (Florentine 1999, Florentine and Fox 2002, Rio Tinto 2017).

In another study by Argus et al. (2014b) the health of *Eucalyptus victrix* and *E. camaldulensis* subjected to prolonged flooding in the Pilbara was assessed. They found that, at the population scale, canopy cover decreased by over 40% in trees rooted in the stream bed of discharge sites compared with trees on the banks of the stream, concluding that, while the health of these trees declines with prolonged flooding, the effects are localised to areas of constant inundation (Argus et al. 2014b).

E. camaldulensis, by contrast, is not only drought tolerant due to its deep rooting ability, it is also more tolerant of flooding, likely as a result of its ability to form a large (up to 40 m radius) network of lateral adventitious roots and its large root xylem vessels (Rio Tinto 2017). Studies have found that this species may tolerate an increase in depth to groundwater of up to 4 m (Maunsell 2006) i.e. drying conditions. It can also undergo major morphological changes to adapt during periods of flooding such as adventitious root production and stem hypertrophy in the early stages of growth, resulting in maintenance of the plant's health, however in the study this was observed to occur for short periods of flooding only (i.e. approximately two weeks) before health began to decline (Argus et al. 2014a). Argus et al. (2014a) hypothesised that flooded *E. camaldulensis* seedlings' root growth would recover and increase rapidly after cessation of flooding, however they found that root recovery after flooding had was poor, with no change in root mass once plants were drained. Nevertheless, *E. camaldulensis* is considered to be the more resilient of the two species in terms of survival in flooded conditions and also appears to be reliant on flooding for recruitment (Department of Water 2010). In assessing the response of *E. camaldulensis* to drawdown, consideration should be given to the lag time between the lowering of groundwater and evidence of tree health decline, which may take up to six months (Commonwealth of Australia 2019).

Is it important to recognise that studies to understand the sensitivity of specific plant species or GDV as a whole, to changes in the availability of groundwater is complex, still ongoing and is likely not able to be definitively concluded due to spatial and temporal variations, and species' physiological variations at different growth stages. Obligate phreatophytes[3] will naturally be very sensitive to reductions in groundwater in the scale of 4-5 m below ground level as this is thought to be their only mechanism for water uptake, while facultative phreatophytes (e.g. *E. camaldulensis* or *E. victrix,* the GDV indicator species relevant to this survey area) may be able to tolerate much larger increases in depth to groundwater as they are also able to meet their water needs within the soil profile. Tolerance of species typical of Pilbara GDV to increased soil moisture can be inferred based on other studies conducted over short periods of times (months) but longer-term studies are needed to improve the state of knowledge around the effects of constant long-term (years) inundation.

5.0 Recommendations

The following recommendations are made with reference to the Atlas Water Management Plan (Atlas Iron 2022) and Biota's experience designing previous GDV monitoring programmes. These recommended actions are suitable for monitoring all riparian vegetation, including GDV.

1. Before the commencement of any dewatering and discharge, conduct a monitoring baseline survey with appropriate impact and control sites, focussed on the four factors most likely to be influenced by changes in water availability:
   - vegetation structure (based on the height classes and density/foliar cover of the dominant perennial flora species);

[3] No obligate phreatophytes were recorded in the McPhee Creek survey area.

- floristic composition and diversity;
- degree of weed invasion; and
- vegetation condition.

2. Vegetation monitoring sites should be established next to groundwater monitoring bores so that depth to groundwater data can be utilised to interpret results.

3. Monitoring (impact and control) sites should be adequately replicated and record the following:

   - floristic composition (measured in 10 x 10 m quadrats established in a continuous belt approach, along a transect positioned perpendicular to the direction of stream flow spanning creek bed and bank habitat; percentage foliar cover and average height to be estimated for each species);
   - foliar cover of each weed species within each of the 10 x 10 m quadrats;
   - a rating of vegetation condition based on the scale provided in EPA guidance (EPA 2016); and
   - percentage foliar cover and size of dominant overstorey tree species, achieved by estimating the canopy cover and measuring height and diameter at breast height (DBH; stem diameter at 1.3 m above ground) for all individuals >1 cm DBH present.

4. Monitoring phases should be completed annually as a minimum.

I hope the information contained herein is adequate for your needs. Please contact me if you require more information.

Yours sincerely,

Biota Environmental Sciences Pty Ltd

Preeti Chukowry
Principal Environmental Scientist

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